Space Weather Technical Forecast

Issued on Tuesday, 15 August 2023 at 13:05 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Peak G1 risk before midweek, falling with time. Chance of R1 throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity, as measured at GOES16, has been Low over the past 24 hours, with the peak flare a long-period C8.9 from AR3405 at 14/2110UTC on a background of declining low C-class.

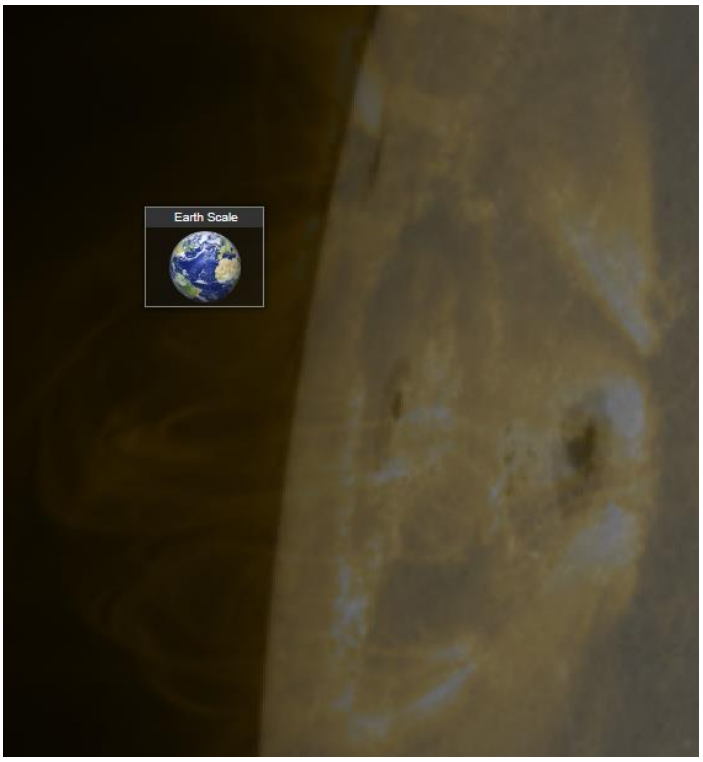


Figure 0: Helioviewer.org-generated composite image of AIA171 and HMIIF at 15/0900UTC, showing region AR3405 and perhaps a second region to its immediate northeast. Earth and curvature of solar horizon shown for scale.

There are now up to seven sunspot regions on the disc, with two small new unnumbered bipolar regions in the southern solar hemisphere. AR3405, the sunspot responsible for the peak flare and perhaps the largest region on the disc is now hoving into view over the northeastern limb. this spot group is currently manifesting as an Eso/Beta and perhaps even an Fso/Beta, should a higher latitude trailing spot not form part of another region to its east. This was rivalled in complexity by AR3403 in the north-centre disc, which showed a spreading tendency, areal growth and proliferation of its intermediate spots to finish the 24 hours as a Dai/Beta. The

© Crown Copyright 2023. All Rights Reserved.

remaining regions on the disc were mainly simpler or decaying bipolar groups.

There were up to three Coronal Mass Ejection (CME) events noted on available coronagraph imagery in the past 24 hours - the first from the aforementioned peak flare, and a second that has been inferred as most likely from the far side eastern solar hemisphere, and the third from behind the western limb in the current UTC morning. Modelling has not yet been conducted on the third of these events, but none is expected to affect Earth. No Earth-bound CMEs were noted.

Solar Wind / Geomagnetic Activity: The solar wind, as recorded by ACE at L1, was characterised by an ongoing slow solar wind regime, but with some late-period signs of an imminent fast wind (rising density and IMF).

The solar wind speed showed a falling trend within Background levels - from 350 to 300km/s. The solar wind density showed a steady tendency near the long-term background in single figures ppcc, while the IMF was similarly subdued below 5nT throughout. The north-south component of the field was mainly anti-aligned with Earth's but small in magnitude, ranging between -4 and +3nT. The phi angle was erratic but within a negative sector (towards the Sun).

The net result of the above solar wind measures was for provisionally Quiet geomagnetic indices throughout.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at Background.

GOES16 high energy (greater than 2MeV) electron flux varied between Normal Background and High with the diurnal cycle, peaking 1250pfu at 14/1330UTC. The associated 24-hour integrated fluence remained below Active (1e8 integrated pfu) reaching 4.77e7 integrated pfu at 15/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: There is a daily Chance of activity rising to Moderate levels with isolated M-class flares. Western solar horizon departures are expected to be roughly compensated for by eastern limb groups, giving a broadly flat trend.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs in the forecast. There are up to two fast wind streams due in the period, respectively CH33/+ which will be the more potent if it manifests, and then CH35/-, which is perhaps most likely midweek. Current Quiet conditions carry a Chance of rising to G1 in the near-term, with this risk falling back to Quiet later in the working week as any fast wind regimes mature and then wane.

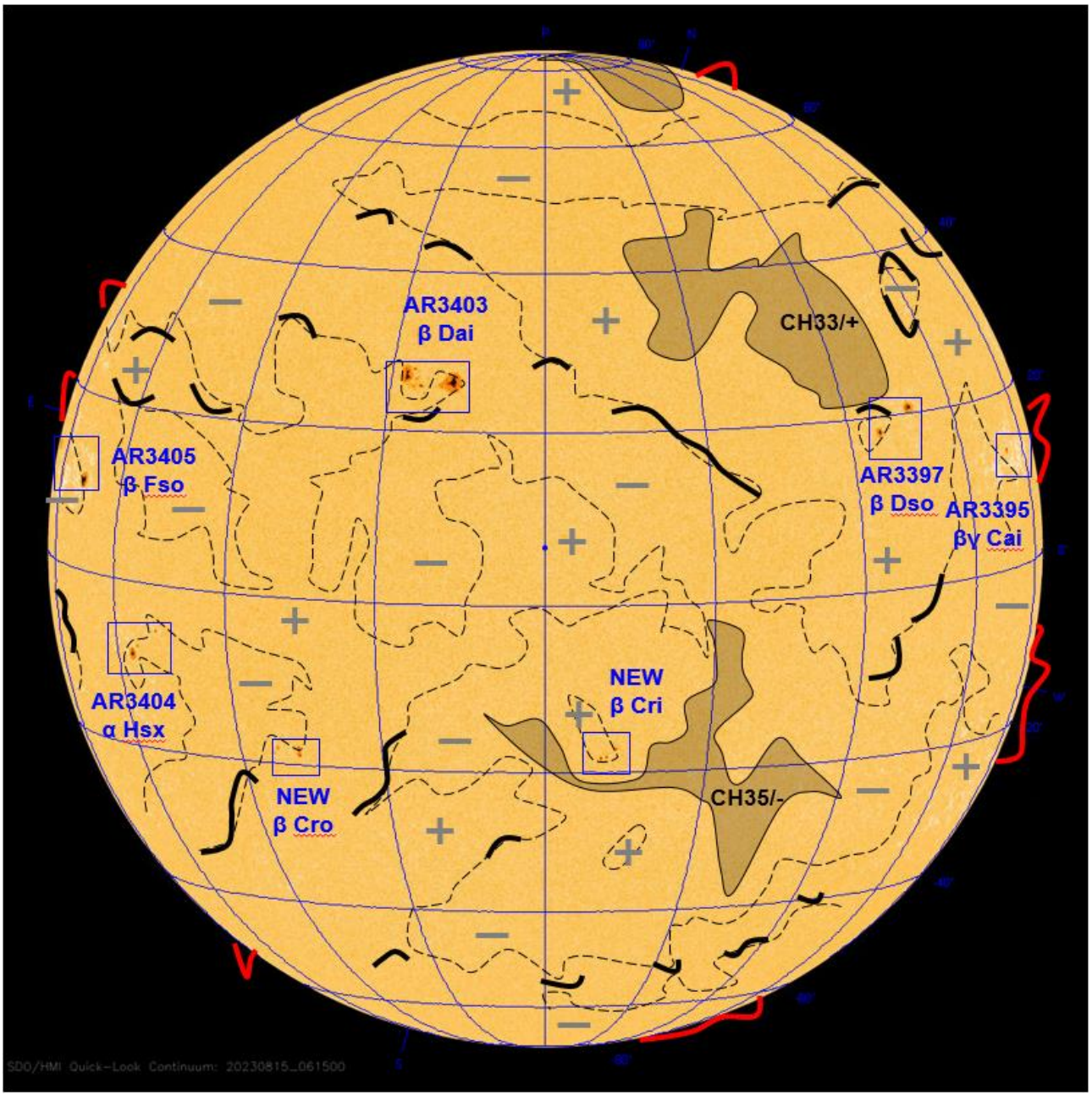
Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to persist at Background.

High energy electron flux (greater than 2MeV) is forecast to continue varying between Background and High levels at first, but with a degree of suppression at GEO expected through midweek in the fast wind regime(s). Recovery is likely later in the working week, but with the magnitude uncertain.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Figure 1. Solar Analysis Valid 15/0615UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Geomagnetic Storms:

There are no Earth-directed CMEs in the forecast.

Current slow wind conditions are forecast to undergo a now-belated increase from CH33/+ inside the current UTC day. STEREO A has now crossed the Sun-Earth line to again lead Earth in terms of angle, however it has a closer orbital radius of 0.95AU that means that it still provides around a five-hour or so lead time by virtue of the nature of the Parker Spiral. There are very recent signs of a SSBC having occurred here at 15/0900UTC, which would mean Earth may experience similar around 15/1400UTC. The magnitude of this enhancement is as yet small - less than 10nT with no significant density or speed increases seen, however this may yet evolve, with STEREO's density trace historically not a good proxy for conditions affecting L1 and Earth.

Upon onset, as a positive polarity coronal hole, there is a higher chance of a potent connection at this time of year. This must be taken with the fact that its late arrival must infer a slower emanating fast wind however, or at least more marginal connection. This fast wind is also significantly later than MOSWOC Enlil indicates, as the model appears to be anomalously generating a high speed stream from an area of weak fields currently in the west-centre disc.

The tenure of any fast wind from CH33 is now expected to be relatively short, perhaps only 24 hours, as it should soon pass the baton to the more assuredly Earth-affecting CH35/-. The reason for the higher confidence arises its position straddling the solar equator (via its northern promontary portion). This is of the wrong polarity to generate a significant risk of G1 given the time of year, however it does serve to prolong the now-reduced risk from CH33/+ before it.

Overall, a peak Chance of G1 through midweek should have waned by the coming UTC weekend to leave more reliably Quiet conditions by this time.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	40	20	20	1
Strong	**G3**	No	1	1	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

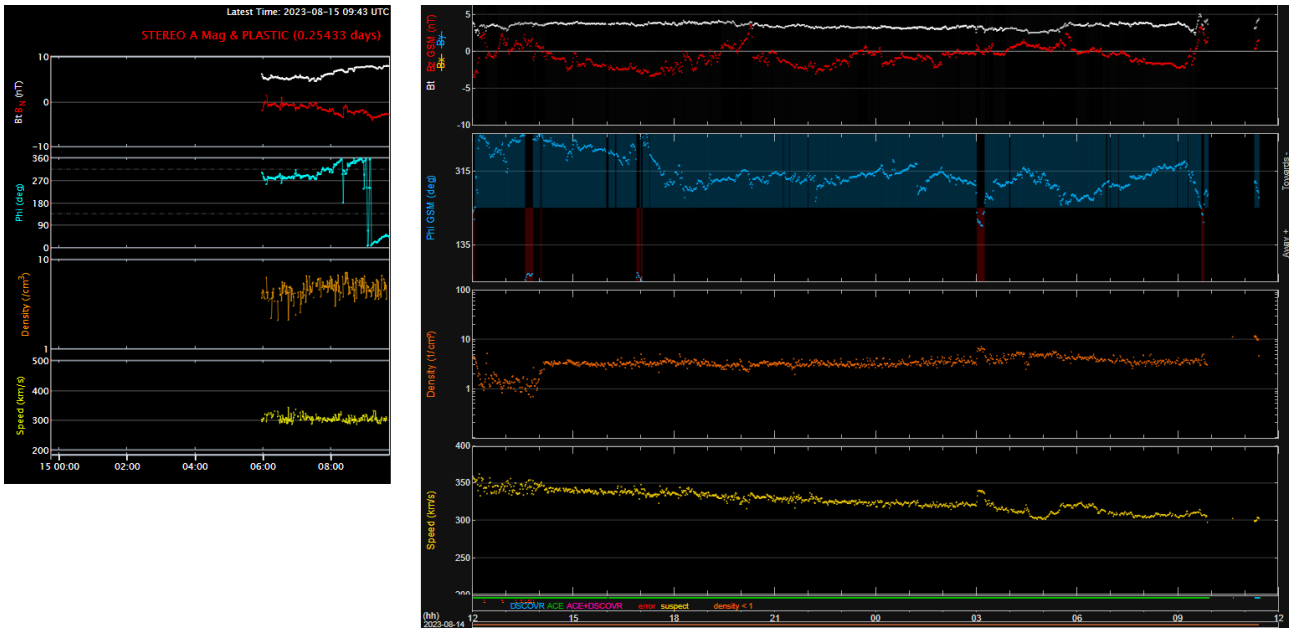
Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Figure 2: (Left) STEREO A MAG and PLASTIC measurements showing a possible SSBC around 15/0900UTC. The recent L1 solar wind as recorded by ACE (right) has become more restive in advance of this, and the overdue CH33/+ may now shortly become geoeffective.



Radio Blackouts - X-Ray Flares:

Solar activity is currently Low, however there is a daily Chance of Moderate activity, with the most probable culprits being the centre-disc growing region AR3403, or else the newly-arriving AR3405. The latter has offered the peak activity of the past 24 hours, including a CME, which will become increasingly relevant by the weekend should it continue this habit. The narrow viewing angle is preventing proper analysis of this group at present, and the extent of the containing plage is unclear. This may well mean that a third penumbral spot now becoming visible at higher solar latitude may be calved off from AR3405 to constitute another new region. The difference this may make to the global probabilities of flares is not likely to be large, as even without this easternmost spot, AR3405 would still have sufficient span to be an Eso/Beta.

Regarding the balance of sunspot group numbers, up to two groups leave the disc later this working week, and there are signs that after a hiatus of a couple of days, further regions may arrive over the eastern limb to mitigate. Overall therefore, the flare risk is held constant.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	40	40
Very Active	R3 to R5 X Class	No	1	1	1	1

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Figure 3: SIDC-ROB processed locations of C-class flares and above from the last 24 hours, showing the oncoming AR3405 is providing the bulk of recent activity, with a minor contribution from AR3403 nearer centre-disc. Both regions will likely be present throughout the forecast period.

Solar Radiation Storms - (High Energy Protons):

The flux of high energy (greater than 10 MeV) is at Background. Some of the more complex sunspot regions are still some days away from the better-connecting western horizon, and in any case they have yet to produce significant flare activity. Because of the subdued current disc, barring any further development the proton flux is expected to remain at background.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	2	2	2
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux at GOES16 has been varying between Normal Background and diurnal peaks of High (above 1000pfu). This is similar in character to its habit of the past few days, however its continuation through the midweek period is unlikely as up to two fast wind streams are expected to suppress electron counts at GEO for a time.

Confidence in the intervening time period is perhaps a little lower relative to recent issues of this guidance - due to the overdue nature of CH33's fast wind. As stated, however, the chances of avoiding any high speed stream from trans-equatorial CH35 are considered very low. The extent of any rebound is therefore the main uncertainty for the forecast overall, rather than the timing, which is reasonably likely to take place late this working week. This should see fluence perhaps responding from late day three, Thursday 17 August. The coronal holes on the disc were present

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

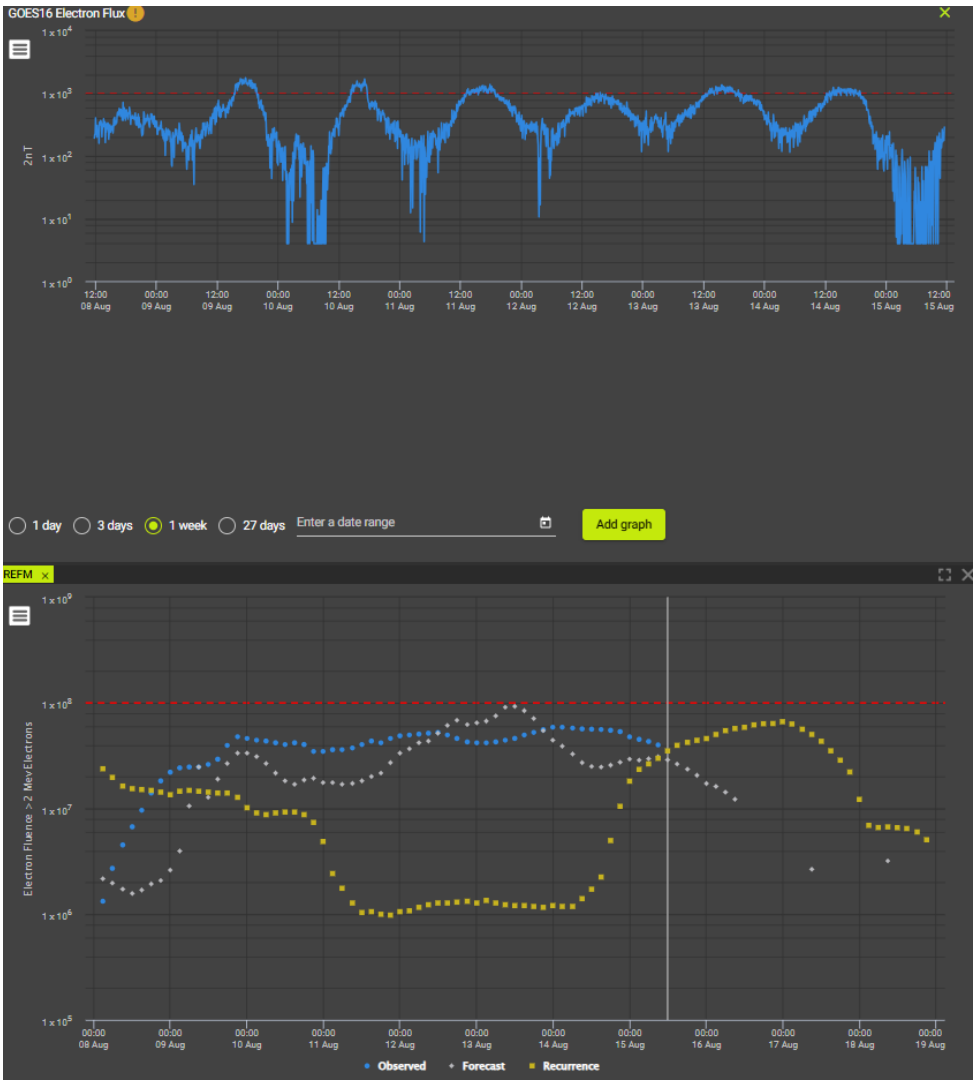
© Crown Copyright 2023. All Rights Reserved.

on last pass, but geometry changes serve to lower confidence in persistence, even in the absence of any complicating transient effects.

An overall Chance of Active is posited for late this UTC week, with the risk very low prior to this.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	10	30	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: The past UTC week in GOES16 high energy electrons (top), as well as oberved fluence (bottom, blue dots). These very stable levels have been the result of a forecast devoid of significant CMEs and fast winds, however this oscillation should soon come to an end under the twin drivers of CH33 and then CH35.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.